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No. 18, January 2010

WAYS TO STRENGTHEN THE FIELD OF VERIFICATION

20 February 2009, United Nations, New York

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Foreword

The Secretary-General's Advisory Board on Disarmament Matters held its two annual sessions in New York from 18 to 20 February 2009 and in Geneva from 1 to 3 July 2009, respectively. As part of the improvements made in its method of work since 2008, the Board focuses its deliberations during both sessions on two or three substantive agenda items. In 2009, one of its agenda items for discussion included "ways to strengthen the field of verification, including the role of the United Nations." The Board was able to conduct an in-depth exchange of views on the topic of verification, with particular emphasis on nuclear verification issues. With regard to the item, the Board suggested that the Secretary-General encourage Member States to provide feedback on all studies that have been done in the field of verification for lessons learned purposes and for a better understanding that a "one-size-fits-all" approach in the field of verification could be counterproductive. The Board also felt that although the United Nations had primary responsibility in dealing with international peace and security issues, it could consider a role for regional organizations in verification matters.

As is customary, the Board heard presentations pertaining to its agenda from representatives of non-governmental organizations during both of its sessions. On the subject of verification, presentations were made to the Board members at its fifty-first session in New York by James Acton, Associate in the Non-Proliferation Program at the Carnegie Endowment for International Peace, and Andreas Persbo, Acting Executive Director of the Verification, Research, Training and Information Centre. James Acton made a presentation entitled "Verifying zero: long-term aims, short-term steps" while Andreas Persbo spoke of "Nuclear arms control in the 2010s—verification challenges". The United Nations Office for Disarmament Affairs (UNODA) is grateful to both for their respective presentations to the Board.

UNODA is publishing this Occasional Paper *for the benefit of all those who were unable to participate, in an effort to stimulate further interest and discussions on verification issues.*

- Ed.

Presentations

I. Verifying zero: long-term aims, short-term steps

by James M. Acton[1]

Abstract

Verifying nuclear disarmament poses an unprecedented technical challenge. There can never be certainty that nuclear-armed States have not retained militarily significant stockpiles of fissile material. In the short term, to help prevent these uncertainties from becoming a roadblock in the future, these steps could, inter alia, (a) collect and archive information about fissile material production; (b) place information about fissile material production and holdings in the public domain; (c) be more transparent about civilian nuclear materials; and (d) implement the proposed Fissile Material Control Initiative. On their part, non-nuclear-weapon States could be prepared to recognize these as meaningful steps towards disarmament.

WHAT I'D LIKE TO TALK ABOUT stems from a project that George Perkovich[2] and I undertook, which was to objectively analyse the challenges confronting nuclear weapons abolition and how they might be overcome. Our book, *Abolishing Nuclear Weapons: A Debate*, contains a reprint of the original Adelphi Paper, *Abolishing Nuclear Weapons*,[3] together with 17 responses from 13 countries that cover a range of political perspectives. These responses engage some of the issues discussed in the original paper.[4]

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[1] Dr. James Acton is an Associate in the Non-proliferation Program at the Carnegie Endowment for International Peace.

[2] George Perkovich is Vice President for studies and director of the Non-proliferation Program at the Carnegie Endowment for International Peace.

[3] The paper was published in September 2008 by the International Institute for Strategic Studies.

[4] See the Carnegie Endowment website for the full text, available at http://carnegieendowment.org/publications/index.cfm?fa=view&id=22748&prog=zgp&proj=znpp (accessed 9 October 2009).

I would like to look at two issues. Let us start by imagining that there was an abolition treaty in place. How might it be verified? This exercise will help highlight the difficulties that would be encountered. Secondly, in light of those difficulties, what can and should States be doing in the short term to help advance the longer-term goal.

Three separate verification tasks can be explored in the disarmament process. The first would be for nuclear-weapon States (NWS) to assure non-nuclear-weapon States (NNWS) that their declared nuclear weapons were being dismantled. The second would be to ensure that no States possessed clandestine undeclared fissile material, which may or may not be in the form of nuclear weapons. The third would be to certify that any existing nuclear activities remained of a peaceful nature. This third task shares many similarities with International Atomic Energy Agency (IAEA) safeguards today and is discussed extensively in the Adelphi Paper. It is the second task, which I consider the most difficult, that I wish to focus on. Scouring an entire State for a small stockpile of highly enriched uranium (HEU) or plutonium is not feasible, and fears over the existence of clandestine material could become a severe roadblock at low numbers. While this is a critical problem, there is some room in the short term to make progress on a solution.

As with any verification process, the first step would be declaration submissions. One could envisage all nuclear-armed States[5] submitting comprehensive declarations that would encompass how, where and when much fissile material was produced, along with its chemical form and isotopic composition. Such declarations would have to include all fissile materials, not just U-235 and Pu-239.

The role of the inspectorate would essentially be twofold. Firstly, the inspectors would have the relatively straightforward task of verifying that the declarations were correct, i.e. that all declared nuclear materials were in their stated locations and forms. Confirmation would create a baseline for all future efforts to ensure that declared nuclear

[5] The term nuclear-armed States refers to all States that have acquired nuclear weapons without violating international law, but does not focus solely on the NWS as recognized by the Nuclear Non-Proliferation Treaty (NPT). In addition to China, France, Russia, United Kingdom and United States, India, Pakistan and Israel are also included in the discussion.

material remained in civilian use. Secondly, they would have the more difficult task of ensuring that the declarations were complete, i.e. that no State possessed undeclared fissile material.

Before talking about the verification process, and to make this discussion somewhat more concrete, it is worth pointing out that the United Kingdom and the United States have published impressive amounts of historical information on the production of highly enriched uranium and plutonium, including some details of their current holdings (although some of this information has become slightly dated). The challenge facing inspectors is to verify, in the case of the United States, that none of its stockpile of 600 metric tons (MT) of HEU and about 100 MT of plutonium has been siphoned off.

One challenge in assessing the completeness of declarations is for inspectors to estimate, as accurately as they could, how much fissile material each State had produced. Nuclear-armed States could facilitate this by handing over all of their records documenting fissile material production. These could then be examined alongside the declarations for self-consistency. Inspectors would ask if the declarations and supporting documents made sense and whether or not there were any obvious errors or inconsistencies. Traditional forensics analysis might be helpful here. For example, inspectors could analyse the documents to check that the paper and ink were of the right age. Even simple tests like this may detect potentially significant large-scale cheating, but not smaller diversions. Interestingly, however, the shift from paper to electronic computer records over the past 10 to 15 years, which is sensible for efficient housekeeping, has made the task of verification somewhat more difficult.

Therefore, it is important that nuclear forensics is available to enable inspectors to reconstruct the history of, say, a reactor and estimate how much plutonium it produced. This kind of technique would not just be useful for verifying compliance of a future hypothetical abolition treaty, but could prove extremely useful in the Democratic People's Republic of Korea (DPRK) today. Successful verification of DPRK's plutonium programme would be a significant demonstration of the feasibility of abolition.

There is an immensely promising technique for graphite-moderated reactors, which account for 34 out of 45 reactors around the

world that have produced plutonium for nuclear weapons. Unfortunately, there are no equivalent techniques for heavy water-moderated reactors, which account for the other 11, or for enrichment facilities.

The bottom line is that inspectors are never going to know exactly how much fissile material each State has produced, let alone whether it has all been declared. In fact, it is inevitable that the uncertainty will be approximately a few per cent of total production.

An uncertainty of 5 per cent in the amount of HEU produced by the United States would be equivalent to about 31 MT of HEU or roughly 3,100 warheads. For the United Kingdom's smaller stockpile, a 5 per cent uncertainty would be equivalent to 1 MT of HEU, or 100 warheads. Now, if the IAEA were tasked with verification, it would attempt to detect the diversion of one significant quantity of HEU (25 kilograms (kg)) or more. Of course, 31 MT or even just 1 MT is substantially larger. So, based on today's technology, it is impossible to verify fissile material production within the IAEA standards. Moreover, technological changes that would make a significant difference to this conclusion are unlikely. Uncertainties might get smaller, but they are not going to get anywhere near the 25 kg target. If there is no constructive thinking about how to solve this problem, then uncertainties over fissile material inventories could lead to fears that a State might be secretly hiding fissile material, creating a significant barrier to disarmament.

Fortunately, in at least one previous situation this problem was not a barrier to disarmament. South Africa abandoned its nuclear weapons programme and dismantled its nuclear weapons. It then invited the IAEA to verify its fissile material production. Ultimately, however, the IAEA could not rule out the existence of a small clandestine HEU stockpile larger than 25 kg. The IAEA Director General could report nothing stronger than "having regard to the uncertainties normally associated with data of this nature, the uranium-235 balance … of the pilot plant is consistent with uranium feed". Nonetheless, while a few analysts questioned South Africa's good faith, the vast majority of States and outside observers felt content with the verification process. There were no serious charges levelled against South Africa that it had retained a clandestine HEU stockpile.

Significantly, South Africa cooperated proactively with the IAEA. It gave access above and beyond any legal requirements, fully briefed inspectors on the programme and made its documents available. It also fully answered inspectors' questions in a timely manner. While South African transparency and cooperation did not allow the IAEA to prove mathematically that there was no clandestine stockpile, it did convince the inspectors on the ground that South Africa had nothing to hide. The question that stems from this is: would this model be more broadly applicable elsewhere? Can we imagine the "South Africa model" of proving good faith through transparency and cooperation being applied to other States?

There are at least three factors that suggest this would be difficult. Firstly, all of the eight nuclear-armed States today have much larger fissile material inventories than South Africa ever did, and their stockpiles have correspondingly larger uncertainties. Secondly, their programmes have generally been in existence for much longer periods of time with more incomplete records than South Africa's. Finally, and perhaps most significantly, these eight nuclear-armed States may have greater incentives to cheat. The reason why South Africa's good faith was not questioned was in part due to its widely applauded process of regime change. Moreover, it had no significant external threats to prompt it to cheat. People did not see any political reason for South Africa to act in bad faith. However, this might not be true for today's nuclear-armed States.

If the South Africa model is to be successfully applied to the other nuclear-armed States, it would require a much longer confidence-building process, involving greater transparency (as political conditions allowed) along with more formal verification. In this model, the nuclear-armed States would put information forward, and if no contradicting evidence of cheating emerged, then credibility would be gradually built up, eliminating the difficulties of doing one-off, one-shot verification. A key step within the confidence-building process would be for a verified fissile material cut-off treaty (FMCT) that covered stocks. The verification arrangements for such a treaty would not need to be as stringent as those required for the abolition of nuclear weapons. However, by putting forward and verifying information on stocks, so long as no irresolvable evidence of non-compliance emerged, confidence in the declarations would begin to build.

I will not focus on a verified FMCT with stocks, as it cannot currently be considered a short-term objective. However, I will discuss four practical steps for the nuclear-armed States to take in the short term to facilitate confidence-building.

The first step is to collect information that might otherwise be lost. We argue in the Adelphi Paper that the nuclear-armed States should appoint national commissions to document their weapons programmes as completely as possible. One of the future problems for verification is that there are not many records on plant operating. The first generation of scientists associated with nuclear weapons programmes have passed away, leaving many important questions unanswered. The situation will get progressively worse without stringent archiving and information maintenance. Thus, national commissions should collect operating records, interview personnel and piece together a coherent narrative.

It is important to recognize that some States currently view transparency in respect to fissile materials as undermining their interests due to its potential to precipitate competition in fissile material production throughout certain regions. While it is necessary to be sensitive to this possibility, it should not stop nuclear-armed States from compiling confidential histories. Also, as political conditions change, good faith is required to prevent States from using difficulties with transparency as an excuse.

Secondly, where possible, nuclear-armed States should be more transparent, specifically regarding fissile material holdings and inventories. There is scope for other States to emulate the declarations put forward by the United Kingdom and the United States on their fissile material holdings. Such declarations should not be viewed as one-offs. As States are able to put more information into the public domain, they should supplement previous declarations. So, while the United Kingdom and the United States efforts are very laudable, they could and should add to them.

A third possible area for increased transparency is civilian HEU and plutonium. Given that this is not military material, objections to transparency should not hold. On a positive note, all five of the acknowledged NWS, along with Germany, Belgium and Japan, submit

annual declarations to the IAEA about civilian plutonium holdings.[6] The United Kingdom, France, and Germany include HEU in their declarations. Other States should build upon this initiative and move for inclusion as well. This initiative also provides an opportunity to bring India, Israel, and Pakistan into the process.

In addition to declaring their civilian fissile material holdings, nuclear-armed States could also place them under international safeguards. The situation at the moment is complicated. Each of the five recognized NWS has what is called a "voluntary offer arrangement" with the IAEA, whereby it gives the Agency a list of facilities that may be safeguarded. However, due to budgetary constraints, the IAEA safeguards only a small number of facilities on each list. To address this, States could increase the number of facilities on their lists. Some of these voluntary-offer arrangements are more extensive than others. For example, as the civilian facilities for the United Kingdom and France are under European Atomic Energy Community (EURATOM) safeguards, their lists are very comprehensive. However, the lists for other States are less comprehensive.

There is also a need to increase funding for safeguards. At the moment, it is prohibitively expensive for the IAEA to safeguard most NWS facilities. Therefore, it is reasonable that those States make more funds available to cover the costs of safeguarding their own facilities. The long-term aim should be to place all civilian facilities in every State under safeguards. It is important to remember that this is disarmament-related, as the same uncertainties surrounding military fissile material on the way to zero could also be raised concerning civilian material.

The final concept I would like to raise, the Fissile Material Control Initiative (FMCI), was proposed by Robert Einhorn[7] at the 2008 International Conference on Nuclear Disarmament in Oslo. This is an interesting initiative that deserves greater attention than it has received. Essentially, it is a comprehensive security, transparency and verification initiative. It would be "a voluntary, multilateral arrangement open to any country that possessed fissile material (whether

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[6] The IAEA initiative known as INFCIRC/549 is available at: http://www.iaea.org/Publications/Documents/Infcircs/1998/infcirc549.pdf (accessed 13 October 2009).

[7] Robert J. Einhorn is a special adviser to the United States Department of State.

safeguarded or not)…".[8] States that chose to participate would sign up to an agreed set of goals and principles to include: (a) increasing security, transparency and control over fissile material stocks worldwide; (b) preventing theft or diversion to non-State actors or additional States; and (c) moving fissile materials verifiably and irreversibly out of nuclear weapons and into forms unusable for nuclear weapons.

This is an attractive idea that should be seriously considered for two reasons: (i) it ties in with the concept that if States are serious about going to zero, they need to start confronting verification problems in advance; and (ii) it increases the feasibility of an FMCT. One of the central FMCT debates surrounds stocks. Some countries insist that they would only sign a treaty that included stocks, while others maintain that stocks must be excluded. The FMCI offers a practical way to narrow this gap by acclimatizing States to the kind of verification and transparency measures that an FMCT involving stocks would require. Therefore, it would help reduce the opposition of those States that would prefer to exclude stocks. Simultaneously, those States that want stocks included may become more willing to live without them because the FMCI provides an alternative means of addressing their concerns. Thus, the FMCI may significantly help pave the way for an FMCT, in addition to making progress on some of the longer-term challenges discussed earlier.

In conclusion, while verifying the abolition of nuclear weapons would be an unprecedented technical challenge, the nuclear-armed States could begin laying much of the groundwork today. Verification should not become a one-off initiative, contemplated at some time in the future when States become serious about negotiating zero. Putting the right transparency measures in place now could help overcome inevitable uncertainties in the long term. That said, as many of the initiatives discussed in this presentation are not often publicly recognized as meaningful steps towards zero, it is important that NNWS acknowledge them as such.

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[8] See "Controlling Fissile Materials and Ending Nuclear Testing" by Robert J. Einhorn, available at http://www.ctbto.org/fileadmin/user_upload/pdf/External_Reports/paper-einhorn.pdf (accessed 13 October 2009).

II. Nuclear arms control in the 2010s—verification challenges

by Andreas Persbo[1]

Abstract

This presentation centred on the nuclear non-proliferation question, including the Fissile Material Cut-off Treaty (FMCT), nuclear testing and a description of the United Kingdom–Norway initiative. It also highlighted two projects to support the verification regime, the Information Barrier, which aims to assist inspectors in ascertaining whether a transport container contains a nuclear weapon or not and an on-site inspection methodology that gives the inspectorate the needed access to verify nuclear warhead dismantlement without revealing proliferation-sensitive information.

THIS PRESENTATION FOCUSED ON THREE MAJOR ISSUES, beginning with the nuclear non-proliferation question, including the Fissile Material Cut-off Treaty (FMCT), moving on to nuclear testing and ending with a description of the United Kingdom-Norway initiative, which relates in many ways to the previous presentation.

It is well known that the 1968 Nuclear Non-Proliferation Treaty (NPT) lies at the heart of the nuclear non-proliferation regime. However, one may ask what lies ahead for this Treaty? The most critical question relates to nuclear safeguards. There is a marked interest in expanding nuclear fuel cycle activities worldwide, not only in the Middle East where most of the current effort and focus is concentrated, but in the western world as well.

The question is whether, at present, any room exists for some sort of consensus solution on strengthened nuclear safeguards. There is merit to the opinion that in order to make meaningful progress we

[1] Andreas Persbo is the Acting Executive Director of the Verification Research, Training and Information Centre.

must link safeguards to nuclear disarmament. Others may concur on the importance of safeguards without a strong link to nuclear disarmament. The first consideration is to determine whether or not a scope exists for making the Additional Protocol the new safeguards standard. Undeniably, some States see the Additional Protocol as an unnecessary voluntary arrangement that in many ways is too intrusive for too little benefit. Other States publicly assess the need for a linkage between the implementation of the Additional Protocol and progress in nuclear disarmament. Without further progress in disarmament, either regionally or internationally, these States are unlikely to support a push for making the Additional Protocol a new standard. This view is particularly common in the Middle East.

The second question is whether or not there is support for developing a next generation of safeguards, as the current non-proliferation challenges are beyond the capacity of the Additional Protocol. For example, Comprehensive Safeguards—while giving some assurance of no undeclared nuclear activities on the territory of a member State—are largely unable to detect the development of parallel clandestine fuel cycles. This is illustrated in Iran and to some degree in Syria. While the Additional Protocol would give the international community some degree of further transparency, it would not be a panacea to the problem of detecting undeclared activities. Other ways must be explored for the International Atomic Energy Agency (IAEA) to monitor, detect and identify instances of potential non-compliance in such States.

One short-term solution would be through monetary support to ensure that the IAEA was adequately staffed and equipped. At the moment much of the equipment is antiquated and the Agency's Seibersdorf Safeguards Laboratory needs an overhaul. While the IAEA has for years been asking to remedy this, recapitalization is moving ahead slowly and has yet to be realized. The safeguards system has been operating more or less on a zero-growth policy for a number of years now. There are promises from the United States administration about doubling of the safeguards budget. At present, a modest eight per cent increase has been proposed. While that would be quite helpful, it must also be recognized that throwing money into the problem will not solve it. Besides additional funds, equipment and expertise

are required to do the job. This presents another challenge as only a limited pool of people can actually make the grade of inspector.

Strengthening IAEA authority

It is fair to say that the Comprehensive Safeguards Agreements, which still form the basis of the safeguards regime today, are more or less outdated. This can be exemplified by looking at Tuwaitha in Iraq. Tuwaitha was a huge facility with many different buildings. Some were open for inspection while others were stipulated off-limits for the inspectorate. Prior to 1991, the IAEA went into the designated buildings, did their material accountancy and determined everything was satisfactory. What actually transpired was that in spite of the Agency's examinations, year after year, there was a great deal of other production related to nuclear-weapons development. Some of the weapons-related activities were located in buildings next to those that were opened for inspection. Therefore, the inspectors drove right past those buildings, with no idea of what was going on inside. The focus on material accountancy had led to a mechanistic attitude towards verification: inspectors were required to go in, do their predetermined checks and nothing more.

Even though the Comprehensive Safeguards Agreement is in many ways the basis of the safeguards regime, applied by itself it is outdated. Though an NPT requirement, many States have yet to bring safeguards into force. While some may disagree, since none of those States has significant nuclear activities, their non-compliance does not pose a major problem. That said, as safeguards are a legal requirement, they should be implemented. The Small Quantities Protocol (SQP), which is attached to the Comprehensive Safeguards Agreement, suspends most inspection activities in States with limited or no nuclear activities. While recently amended to allow the Agency to obtain additional information in SQP States, its effectiveness not yet known. Additionally, this may present a problem in the future as some States with the SQP in force are suspected of non-compliant behaviour.

It should be a reasonable requirement that all States with significant nuclear activities sign the Additional Protocol (AP) to the Comprehensive Safeguards Agreement as soon as possible. In this way, the IAEA may draw conclusions on the absence of undeclared

nuclear activities. When in force, the AP allows the Agency to get more information on various fuel-cycle activities in States, including on mining and milling, general research and development, centrifuge research and development and so on. However, it is not a system that allows for instantaneous inspections. The basis of the inspection effort is still based on the rules of the Comprehensive Safeguards Agreement, with a limited additional access given under the AP.

The most significant benefit is that it greatly reduces the lead time for inspectors to enter the facilities. However, under current aviation guidelines, as soon as the inspectors check in at the airport, the receiving State is automatically alerted in advance, before the team actually gets to the facilities. Therefore, calling the visits unannounced is an overstatement. This was recently illustrated in Iran where two days before the actual "unannounced" inspection, Iran knew of the IAEA's visit to the Natanz facility. To reiterate, how to detect an undeclared nuclear activity remains a major challenge to the Safeguards system. Routine inspections themselves cannot detect parallel fuel cycles.

The IAEA has identified other challenges that also need to be addressed in the coming years. One is the bulk-handling reprocessing facilities where the material put through is huge and the "material unaccounted for" (i.e. accounting discrepancies) might be quite significant. The technical solution to this is to relax the timeliness criteria (i.e. whether or not the Agency can detect the diversion within a month). Another challenge relates to uranium enrichment facilities, where new approaches must be examined. Since 2005 the Agency has been looking at a new safeguards approach that gives more assurance, but clearly more needs to be done.

Prospects and opportunities

One exciting prospect that the Agency has been looking at for many years is satellite imagery. Over the past few years, the non-governmental community has made massive strides forward in this, with an informal network of civilian analysts looking at the imagery submitted by satellite imagery providers, often free of charge. The

best non-governmental analysis of the Syrian reactor was provided in quite a short time by the website armscontrolwonk.com.[2]

While it has started its own satellite imagery unit, and more satellite imagery can be shared with the Agency, the IAEA needs monetary support to buy additional imagery products. This is important, inter alia, for scene change recognition, to actually monitor changes in the construction of a facility over time. Looking for a clandestine facility is similar to looking for a needle in a haystack. The more images that can be purchased, the better it is. However, the best imagery data always comes when following up on a lead, often given by national intelligence and States.

Another question is how to harness both the great strides in computing power and the diminishing cost of computer memory. Currently, computer memory is almost too cheap to meter.[3] An example of this was seen at the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO)'s on site inspection exercise in early 2009. Approximately 500 MB (Megabytes) of seismic data was gathered in a large-scale computer bank that contained 10 TB (Terabytes), which in reality can nearly be accommodated today by a personal computer. In the 1990s, the CTBTO's bandwidth requirement was seen as staggering. Today, its data can be easily carried on the Internet. The most advanced computer in 1995 was slower than what many children might have in their new X-Box 360 gaming consoles today. In addition to computer power, data transmission has been harnessed to benefit verification. Transmission costs can be reduced by 20 per cent by simply introducing Virtual Private Networks (VPN) in Safeguards Data Transmission. The question, however, is how to encrypt it to be made safe and secure.

Fissile Material Cut-off Treaty: a rebranded debate

Moving to the FMCT, thus far, most of the research done has virtually covered all aspects of the proposed Treaty. Various drafts have

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[2] Arms Control Wonk is an arms control-related issues blog.

[3] See "Tech Is Too Cheap to Meter: It's Time to Manage for Abundance, Not Scarcity" in *Wired Magazine*, 22 June 2009, available at http://www.wired.com/techbiz/it/magazine/17-07/mf_freer (accessed 9 October 2009).

been circulated, considering everything from scope, to verification, to entry into force. In my mind, the main question today is whether the scope should be full or focused?

The previous presentation favoured a full-scope FMCT. However, there is also merit in addressing only direct-use material and not the entire fuel cycle. This would remove many problems. In addition to reducing costs for the verification regime, it would also divert the need to deal with difficult questions related to, for instance, tritium production and the naval fuel cycle. The focus of the FMCT could then be solely on the "choke-points" of fissile material production. This is what the nuclear-weapon States (NWS) would want to see, and without their support there will be no FMCT.

The inclusion of fissile material stocks is quite impractical for the 5 per cent accounting uncertainty in most NWS. Translated, this means that uncertainties are too big for a meaningful baseline to be established. Some of this uncertainty could be alleviated through the establishment of national commissions, tasked to ascertain, to the greatest degree possible, the exact material balance in the NWS. Under an FMCT, there could be an article that sets out the role of a National Authority, which would include historical accountancy. Another article could issue regulations and give advice, ensuring that the production of fissile materials for weapons purposes would be a crime under national law. This would encourage people on the operational side to think twice before following a Government directive to engage in internationally illicit activities.

Nuclear testing: mixed prospects

With regard to nuclear testing, there are still huge uncertainties as to the entry into force of the CTBT. United States ratification may or may not be around the corner. However, except in those States that are not parties to the Treaty, for instance Pakistan, the International Monitoring System (IMS) is likely to be ready in early 2010. While it is uncertain as to whether Iran will turn on its stations again, most of the System will be ready. Its effectiveness was illustrated in 2006 when the Democratic People's Republic of Korea tested a nuclear device.

Will the CTBTO be able to agree on an on site inspection regime before entry into force? Probably. How effective will it be? In terms of operations, the CTBT Provisional Technical Secretariat knows how to do the job of: (a) getting people on the field; (b) handling material; (c) handling equipment; and (d) devising a search plan. The question of how to get agreement on those procedures is a political problem and not a technical one.

At present, the verification regime as a whole is robust. For instance, IMS is capable of detecting nuclear explosions significantly lower than the 1 kiloton threshold, which was the benchmark at the time of negotiating the Treaty. Currently, most areas of the world are monitored at thresholds much lower than that; technology is progressing. The aftershock monitoring system, which is solely deployed by the on site inspection teams, is so sensitive that it can detect a 75-gram high-explosive detonation at a distance of 2.5 kilometres. It is so sensitive that it can detect rainfall.

Prospects for disarmament

Moving on to nuclear disarmament, it is likely that during the 2010s there will be an agreement on further reductions in the United States and Russian Federation strategic forces. While this is welcome, it is doubtful that reductions would go below 1,000 warheads. There are many figures that have been circulated, all within the 1,000 to 1,500 range.

It is possible that there could be an agreement on the verification of warhead dismantlement. If so, it would require the Trilateral Initiative[4] to be revived as a matter of priority. This is not impossible because many of the people who worked on the Trilateral Initiative in the 1990s are still active in their respective Governments. However, as many of them are close to retirement, it would be useful to devise methods to transmit their knowledge to younger generations so that it can be brought forward.

[4] The Trilateral Initiative is a Russian Federation–United States–IAEA initiative to look at verification questions.

The role of the United Kingdom–Norway Initiative

Established at the beginning of 2007, this Initiative is a research collaboration between the Verification, Research, Training and Information Centre (VERTIC), the United Kingdom Atomic Weapons Establishment and a number of Norwegian research institutes. After two years, the working relationship has deepened, but the first year was spent building trust between all the participants through preliminary research, reviews and exploration of areas for possible cooperation. Even between close allies, such as Norway and the United Kingdom, there is a certain level of caution that needs to be applied on matters relating to nuclear weapons dismantlement and verification, which makes the parties uneasy to move forward. There are safety and security issues on the part of the United Kingdom, which take its obligation under Article I of the NPT[5] very seriously. In addition to proliferation concerns, safety considerations also prevent Norwegian researchers from admittance into the Atomic Weapons Establishment. The Norwegian Government takes its obligation under Article II[6] equally seriously.

This situation gave rise to serious proliferation concerns. The Norwegian scientists, cautious to move forward, were actually afraid of learning too much. It is often assumed that non-nuclear weapon States (NNWS) inspectors, when called upon, will rush to the task and do their job. This is erroneous as there are both legal and political issues to be considered first.

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[5] Article I of the NPT states that "Each nuclear-weapon State Party to the Treaty undertakes not to transfer to any recipient whatsoever nuclear weapons or other nuclear explosive devices or control over such weapons or explosive devices directly, or indirectly; and not in any way to assist, encourage, or induce any non-nuclear weapon State to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices, or control over such weapons or explosive devices."

[6] Article II of the NPT states that "Each non-nuclear-weapon State Party to the Treaty undertakes not to receive the transfer from any transferor whatsoever of nuclear weapons or other nuclear explosive devices or of control over such weapons or explosive devices directly, or indirectly; not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices; and not to seek or receive any assistance in the manufacture of nuclear weapons or other nuclear explosive devices."

Considerable progress has been achieved in 2008 as we moved from theory to practice. At present, we expect substantial advances on inspection methodology later in 2009, followed by a progress report in 2010.

The Information Barrier is a project underway that aims to construct a device to filter the fissile material spectra when placed between the sensor and the output. When the sensor was to look at a warhead, it would see the full spectra and reveal the isotopic composition of the fissile material core. While the raw data would have to be concealed from the inspectors, the filtering process would illustrate certain peaks in the spectra and then signal a simple "yes or no" answer. The Information Barrier would then take the signal and translate it into a green or red light. When a box came in, the sensor would point to it and the inspectors would see the information barrier display a green light if the box contained fissile material with certain properties, or a red light if fissile material was not present (i.e. for a fake weapon).

Even though it sounds simple, it is surprisingly difficult to build such a device. At the moment, two designs are under construction. One is being developed by the Norwegians as an NNWS Information Barrier and the other by the United Kingdom. The idea is to unite both and produce a joint design in 2009. On the first day, the electrical engineers from the Atomic Weapons Establishment (AWE) and their Norwegian counterparts agreed on basic concepts and equipment needs. By the second day they were able to quote a price of approximately £10 for the device, as well as the estimated size of a cigarette box. The cost of research and development was not included in the price.

While the project is hoped to be completed by year's end, it is unlikely that the Barrier will be reported on during the 2009 NPT Preparatory Committee (PrepCom) in May as the prototype is scheduled for testing in June at an on site inspection.

The on site inspection methodology part of the project included for the first time an NNWS, an NWS and a non-governmental organization (NGO), where the roles were reversed. Playing the part of the NWS, the Norwegian Government created a mock device that, while clearly was not a nuclear weapon, contained some classified properties known only to the Norwegian Government. Their objective was

to make sure that those classified properties, which were critical to the device, were not leaked to the inspectorate.

The project also mapped out a dismantlement flow in an actual nuclear weapons dismantlement facility. It was surprisingly complex, and included at least 30 discreet operations, involving the simple movement of a warhead from its deployment site to the dismantlement facility and then all of the various moves within that facility.

A mock facility was then constructed outside of Oslo, based on Norway's defence research site at Kjeller. As it happens, the site was not only the focus of their defence research establishment but it also had a nuclear reactor, a number of hot-cells and a high explosives storage site. In many ways, it is coincidentally similar to a very small nuclear weapons establishment.

Thus far, the evaluation of the only on site inspection exercise, concluded in December 2008, revealed that United Kingdom participants found it to have a more realistic feel than any previous on site inspection exercises conducted at the AWE. As the exercise in June 2009 will form the basis for the final report, it will be excluded from discussion at the NPT PrepCom in May. However, we will report back to the 2010 NPT Review Conference.

Why an NGO? Early on, VERTIC became instrumental in the process, acting as both technical and legal advisers and supplying many ideas. The Information Barrier project is based on James Acton's ideas and the on site inspection methodology project is based in part on mine.

In many ways, VERTIC guided the entire process. It helped the States get closer to each other and iron out some of their differences. Its working method could be quite usefully exported to other States, initiatives, subject areas and topical areas of verification.

In addition to our non-technical advisory role, we write a number of reports each year. We are contractors of the Ministry of Defense, so ultimately they dictate what we write and report back on. However, we do carry out public diplomacy and in this regard are at relative liberty to speak freely. We produce fact-sheets and give presentations such as this. We also participate in trilateral presentations; the next is scheduled for the third NPT PrepCom on 8 May 2009.

In conclusion, two promising projects are under way to support the verification regime. The Information Barrier filters sensitive information into a simple "green light/red light" output, assisting inspectors in ascertaining whether or not a transport container holds a nuclear weapon. On site inspection methodology gives the inspectorate the access needed to verify the dismantlement of nuclear warheads without revealing proliferation-sensitive information. This may build confidence that NWS are reducing their arsenals, as well as deter them from retaining a clandestine arsenal as they transition to zero nuclear weapons.

Appendix

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Fifty-first session, 18-20 February 2009

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